IMOS Integrated Marine Observing System

FACILITY 10: eMarine Information Infrastructure (eMII)

IMOS NETCDF CONVENTIONS

Conventions and Reference Tables

Version 1.4
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NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is led by University of Tasmania in partnership with the Australian marine & climate science community

UNIVERSITY of TASMANIA AUSTRALIA

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PREFACE to version 1.4

Due to changes in version 2.4 of the IMOS toolbox responsible for the ANMN (Australian National Moorings Network) time series and profile data processing, we have made a number of changes to this document. They are summarised below:

-Document has been renamed from IMOS NetCDF user's manual to IMOS NetCDF Conventions.

-Prefaces to former versions of the IMOS NetCDF Conventions are not included any more. Only the changes from the previous version to the current one are detailed.

-Overall the document has been reviewed and corrected with fixes or updates. There has also been an attempt to reduce information to a minimum trying to cut repetitions and redundancies. The use of hyperlinks to reference information within this document or outside has also been widely spread.

-Chapter 3 -NetCDF File structure has been extended with a sub-chapter on feature type templates with examples of templates for each relevant feature types.

-Global attributes are divided into two categories: the core (mandatory) ones, and the optional ones.

-Compulsory global attribute distribution_statement has been renamed disclaimer and its content updated while a new compulsory global attribute license has been added.

-The global attributes "featureType", "instrument_serial_number", "site", "platform", "keywords", "quality_control_log", "lineage" and "project_acknowledgement" are now optional ones.

-Contents of global attributes "file_version" and "file_version_quality_control" have been updated.

-New optional global attribute "keywords_vocabulary" to define the vocabulary used in "keywords".

-Optional global attribute "project_acknowledgement" has been removed.

-IMOS recommended "units" attribute for time variable is "days since 1950-01-01 00:00:00 UTC" and not local time.

-Variable attributes "valid_min" and "valid_max" must be of the same type as the variable they're associated with.

-Variable attribute "_FillValue" cannot be used for a coordinate variable and is only required if there could be missing values in the data (not mandatory anymore).

-Variable attributes "quality_control_set" and "quality_control_indicator" are not relevant to be used with a non ancillary QC variable anymore.

-Variable attribute “uncertainty” is not mandatory any more for vertical coordinate variables.

-A new variable attribute “coordinates” is mandatory for any measurement variable other than coordinate or ancillary data.

-Variable attribute “reference_datum” is not relevant for non coordinate data.

-Variable attributes “valid_min” and “valid_max” are not relevant for QC ancillary variables.

-Variable attributes “quality_control_global_conventions” and “quality_control_global” have been added for QC ancillary variable.

-QC ancillary variable attribute “quality_control_set” has been removed. Attribute “quality_control_conventions” is already enough and more explicit.

-The CDL file example in Appendix 1 has been updated.

-Optional global attributes for the IMOS toolbox “instrument_beam_angle”, “cruise”, “station”, “time_deployment_start_origin” and “time_deployment_end_origin” have been introduced.

-The Reference Table - IMOS parameter dictionary, is not included in this document anymore. Instead a link to an up to date document is provided.

-The Reference Table - BOM Quality Control procedure flags, has been updated.

1 - OVERVIEW

1.1 - About IMOS

IMOS is a distributed set of equipment and data-information services which collectively contribute to meeting the needs of marine climate research in Australia. The observing system provides data in the open oceans around Australia out to a few thousand kilometres as well as the coastal oceans. The IMOS Office coordinates the deployment of a wide range of equipment and assembles the data through 11 facilities distributed around the country. The data are made available to researchers through the electronic Marine information Infrastructure (eMII) located at the University of Tasmania. The IMOS infrastructure also contributes to Australia's role in international programs of ocean observing.

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is led by University of Tasmania in partnership with the Australian marine & climate science community.

1.2 - About eMII

The eMarine Information Infrastructure (eMII) will provide a single integrative framework for data and information management that will allow discovery and access of the data by scientists, managers and the public.

eMII activity can be summarised as follows:

- eMII will host, manage and archive data produced by the other IMOS facilities.
- eMII will provide the standards, protocols and systems to integrate the data and related information into a number of conformal frameworks, and will provide the tools to access and utilise the data.
- For some kinds of data, eMII will provide data products as web services and web features for processing, integration and visualisation of data.
- Where possible, eMII will integrate data from sources outside IMOS into IMOS data products and export IMOS data to international programs.

1.3 - About this document

The main purpose of this document is to specify the format of the files that are used to distribute IMOS data, and to document the standards used therein. This includes naming conventions, or taxonomy, as well as metadata content.

The IMOS NetCDF Conventions document was originally based on the one prescribed by the OceanSITES User's Manual, version 1.1. As both documents have evolved since, there are now significant differences between them but we will try to reduce this gap in the future. The OceanSITES program is the global network of open-ocean sustained time series reference stations that have been implemented by an international partnership of researchers.

The IMOS NetCDF Conventions document also draws on documents that have been produced for the IMOS project (see References).

2 - IMOS DATA FORMAT

2.1 - Network Common Data Form (NetCDF)

NetCDF is one of many file formats available for storing marine data. It is a binary file format that is self-describing and portable among other features. The netCDF software libraries and documentation are available online from Unidata. Many netCDF manipulation and display software utilities are also available online.

The IMOS NetCDF Conventions have been written to be used when writing data files in netCDF classic format (version 3.6). Unidata released a netCDF-4 format in 2008. This format is more flexible than the classic format and offers additional features such as compression, groups, compound types and variable length arrays. NetCDF library versions 4.0 and above are now widely adopted and backward compatible with the netCDF classic format so whenever relevant and possible, eMII encourages data providers to produce netCDF-4 files. Common Data Language (CDL) is a human readable text notation that is used to describe the netCDF objects. The netCDF utility *ncdump* can be used to convert netCDF binary file to CDL text. The netCDF utility *ncgen* creates a netCDF binary file from a well-formed CDL text file.

A CDL example which describes IMOS temperature data collected from a mooring is shown in APPENDIX 1: example netcdf file.

2.2 - CF conventions

IMOS follows the netCDF Climate and Forecast (CF) Metadata Conventions v1.6 (Eaton et al 2011). CF conventions require conforming datasets to contain sufficient metadata that they are self-describing, in the sense that each variable in the file has an associated description of what it represents, including physical units if appropriate, and that each value can be located in space and time. The CF conventions supply a standard vocabulary and some metadata conventions. Sometimes it was desirable to incorporate attributes or concepts from other conventions to the IMOS NetCDF Conventions. We have made clear notations in this document where the IMOS NetCDF Conventions extends the CF ones.

2.3 - IMOS conventions

IMOS NetCDF Conventions require that:

- Units are compliant with CF/COARDS/Udunits.
- The time parameter is encoded as recommended by COARDS and CF.
- Parameters are given standard names from the CF table when possible.
- Where time is specified as an attribute, the ISO8601 standard is used.
- File names are created following the IMOS File Naming Convention document.

See also Unidata netCDF best practices.

3 - NETCDF FILE STRUCTURE

3.1 - Feature type templates

3.1.1 -Definition

Most of the observation data collected by IMOS are discrete sampling geometry datasets, that is to say data sets "characterized by a dimensionality that is lower than that of the space-time region that is sampled; discrete sampling geometries are typically "paths" through space-time" (see CF1.6 new chapter 9). We can identify distinct types of discrete sampling geometry like point, time series, profile or trajectory, so that for each of these feature type we can adopt a consistent representation or template in a netCDF file structure.

The US National Oceanographic Data Center (NODC) has designed netCDF templates for a wide variety of feature types. For each of them there is usually an orthogonal and an incomplete template available. IMOS recommends using the orthogonal template in which variables of a dataset must contain identical coordinate values along an axis. When the variables of a dataset contain different coordinate values along an axis then they should be separated into distinct files.

3.1.2 -Examples of CDL templates per feature type

The examples below illustrate the structure of a file for each feature type, using a single data variable as an example. A file can have multiple data variables as long as they share a single set of coordinates. For clarity, most attributes and the data values have been omitted.

3.1.2.1 - Time series

```
netcdf IMOS_timeseries_ single_dataset {
dimensions:
        TIME = 22345 ;                  // Number of time steps in the time series
variables:
        double TIME(TIME) ;             // Coordinate variable T
        double LATITUDE ;               // Scalar coordinate variable Y
        double LONGITUDE ;              // Scalar coordinate variable X
        float NOMINAL_DEPTH ;           // Scalar coordinate variable Z
```

```
        float TEMP(TIME) ;                  // geophysical measurement variable
                TEMP:coordinates = "TIME LATITUDE LONGITUDE NOMINAL_DEPTH" ;
                TEMP:ancillary_variables = "TEMP_quality_control" ;
        byte TEMP_quality_control(TIME) ;       // geophysical measurement ancillary variable
                TEMP_quality_control: variable_attribute = "variable attribute value" ;
// global attributes:
                :featureType = “timeSeries” ;
}
```

3.1.2.2 - Profile

```
netcdf IMOS_profile_single_dataset {
dimensions:
        DEPTH = 102 ;                   // Number of vertical cells in the profile
variables:
        float DEPTH(DEPTH) ;            // Coordinate variable Z
        double TIME ;                   // Scalar coordinate variable T
        double LATITUDE ;               // Scalar coordinate variable Y
        double LONGITUDE ;              // Scalar coordinate variable X
        float TEMP(DEPTH) ;             // geophysical measurement variable
                TEMP:coordinates = "TIME LATITUDE LONGITUDE DEPTH" ;
                TEMP:ancillary_variables = "TEMP_quality_control" ;
        byte TEMP_quality_control(DEPTH) ;    // geophysical measurement ancillary variable
// global attributes:
                :featureType = “profile” ;
}
```

3.1.2.1 - Time series profile

```
netcdf IMOS_time_series_profile_single_dataset {
dimensions:
        TIME = 250 ;                    // Number of time steps in the time series
        DEPTH = 40 ;                    // Number of vertical cells in the profile
variables:
        double TIME(TIME) ;             // Coordinate variable T
        float DEPTH(DEPTH) ;            // Coordinate variable Z
        double LATITUDE ;               // Scalar coordinate variable Y
        double LONGITUDE ;              // Scalar coordinate variable X
        float CSPD(TIME, DEPTH) ;       // geophysical measurement variable
```

```
                CSPD:coordinates = "TIME LATITUDE LONGITUDE DEPTH" ;
                CSPD:ancillary_variables = " CSPD_quality_control" ;
        byte CSPD_quality_control(TIME, DEPTH) ;      // geophysical measurement ancillary variable
// global attributes:
                :featureType = “timeSeriesProfile” ;
}
```

3.1.2.2 - Trajectory

```
netcdf IMOS_trajectory_ single_dataset {
dimensions:
        TIME = 22345 ;                          // Number of time steps in the trajectory
variables:
        double TIME(TIME) ;                     // Coordinate variable T
        double LATITUDE(TIME) ;                 // Auxiliary coordinate variable Y
        double LONGITUDE(TIME) ;                // Auxiliary coordinate variable X
        float DEPTH(TIME) ;                     // Auxiliary coordinate variable Z
        float TEMP(TIME) ;                      // geophysical measurement variable
                TEMP:coordinates = "TIME LATITUDE LONGITUDE NOMINAL_DEPTH" ;
                TEMP:ancillary_variables = "TEMP_quality_control" ;
        byte TEMP_quality_control(TIME) ;       // geophysical measurement ancillary variable
// global attributes:
                :featureType = “trajectory” ;
}
```

3.2 - Global Attributes

3.2.1 -Definition

The global attribute section of a netCDF file contains metadata that describes the overall contents of the file and allows for data discovery. All fields should be human-readable and can be of either ‘character’ or ‘numeric’ type. IMOS recommends that all listed attributes be used and contain meaningful information unless there are technical reasons rendering this impossible (for example, information not available for historical data). Files must at least contain the attributes listed as “mandatory”. Please contact eMII if this is proving difficult.

Global attributes can be thought of as conveying five kinds of information:

- What: What are the data in the dataset
- Where: The spatial coverage of the data
- When: The temporal coverage of the data
- Who: Who produced the data
- How: How were the data produced and made available

3.2.2 -Core global attributes

The following table lists all the core global attributes are **mandatory** from the point of view of either the CF or IMOS conventions.

The "Type" values are **S** for string, **N** for numeric (byte, short, long, integer, float or double), **D** for the type of the data variable and **Q** for the type of the corresponding quality control data variable.

Table 1 List of core mandatory global attributes for IMOS netCDF files

Name	Type	Example	Definition
What			
project	S	project = "Integrated Marine Observing System (IMOS)"	The scientific project that produced the data. For data produced under the IMOS project, the field must be filled as shown in the example.
Conventions	S	Conventions = "CF-1.6,IMOS-1.4"	Name of the format convention used by the dataset. Possibility to include two different conventions if necessary. For data produced under the IMOS project, the field must be filled as shown in the example.

Non-CF attribute

	standard_name_vocabulary	S	standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table Version 29"	Table number used for CF standard names.
	title	S	title = “Radar data from Tannum Sands station, Queensland”	Short description of the dataset
	institution	S	institution = “ACORN”	Name of the institute or facility where the original data was produced
Non-CF attribute	date_created	S	date_created = “2008-11-23T08:35:00Z”	The date on which the file was created. See chapter **Error! Reference source not found.** on time format below.
Non-CF attribute	abstract	S	abstract = “NSW-IMOS Port Hacking 100m Mooring Water quality meters (WQM's) at one or more depths collect bursting data. Data from the bursts have been cleaned and averaged to create data products. This file is one such product.”	A paragraph describing the dataset: type of data contained in the dataset, how the data was created, the creator of the dataset, the project for which the data was created, the geospatial coverage of the data, the temporal coverage of the data. In some instances the abstract may be autogenerated from other netCDF fields. Please discuss this with eMII staff if you think autogeneration will be appropriate for your data.
Non-CF attribute	naming_authority	S	naming_authority = “IMOS”	This will always be “IMOS”
Non-CF attribute	**Where**			

	geospatial_lat_min / geospatial_lat_max	N	geospatial_lat_min = 59.8 geospatial_lat_max = 59.8	The southernmost / northernmost latitude covered by the data set, a value between -90 and 90 decimal degrees North unless otherwise specified in geospatial_lat_units.
	geospatial_lon_min / geospatial_lon_max	N	geospatial_lon_min =-41.2 geospatial_lon_max=-41.2	The westernmost / easternmost longitude, a value between -180 and 180 decimal degrees East if not specified.
	geospatial_vertical_min / geospatial_vertical_max	N	geospatial_vertical_min = 10.0 geospatial_vertical_max = 2000	Minimum / maximum depth for measurements in metres if not specified.
	geospatial_vertical_positive	S	geospatial_vertical_positive = “down”	Direction towards which depth is positive. Possible values are either “up” or “down”.
Non-CF attribute	**When**			
	time_coverage_start / time_coverage_end	S	time_coverage_start = “2008-11-23T08:35:00Z” time_coverage_end = “2009-01-06T15:47:00Z”	Start / final date of the data in UTC. See chapter **Error! Reference source not found.** on time format.
Non-CF attribute	**Who**			
	data_centre	S	data_centre = “eMarine Information Infrastructure (eMII)”	Data centre in charge of the data management or party who distributed the resource
	data_centre_email	S	data_centre_email = “info@emii.org.au”	Data Centre contact e-mail address

	author	S	author = “Doe, John”	Name of the person responsible for the creation of the dataset. Convention is last name and then first name separated by a comma.
	principal_investigator	S	principal_investigator = “Doe, John”	Name of the principal investigator in charge of the platform. Convention is last name and then first name separated by a comma.
Non-CF attribute	**How**			
	citation	S	citation = Integrated Marine Observing System. 2008, "Australian Acoustic Tagging and Monitoring System (AATAMS) data", http://imos.org.au/emii_aatams.html, accessed 20 Dec 2008.	The citation to be used in publications using the dataset should follow the format: “IMOS. [year-of-data-download], [Title], [Data access URL], accessed [date-of-access]”.

acknowledgement	S	acknowledgement = “Any users (including re-packagers) of IMOS data are required to clearly acknowledge the source of the material in this format: "Data was sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative."”	Information about how to acknowledge the source of the material. For data produced under the IMOS project, the field must be filled as shown in the example. If relevant, also credit other organisations involved in collection of this particular data stream.
disclaimer	S	disclaimer = “Data, products and services from IMOS are provided "as is" without any warranty as to fitness for a particular purpose.”	Statement limiting the liability of the data provider. For data produced under the IMOS project, the field must be filled as shown in the example.
license	S	license = http://creativecommons.org/licenses/by/4.0/	Describe the restrictions to data access and distribution. For data produced under the IMOS project, the field must be filled as shown in the example.

3.2.3 -Optional global attributes

Table 2 below lists some of the **optional** global attributes than can be used by any facility to describe an IMOS netCDF dataset.

For an example of facility-oriented optional global attributes, see APPENDIX 1: example netcdf file.

The “Type” values are **S** for string, **N** for numeric (byte, short, long, integer, float or double), **D** for the type of the data variable and **Q** for the type of the corresponding quality control data variable.

Table 2 List of optional global attributes for IMOS netCDF files

Name	Type	Example	Definition
What			
featureType	S	featureType = “timeSeries”	Specifies the type of discrete sampling geometry to which the data in the file belongs, and implies that all data variables in the file contain collections of features of that type. Possible CF featureType values are “point”, “timeSeries”, “profile”, “trajectory”, “timeSeriesProfile” or “trajectoryProfile”.
date_modified (Non-CF attribute)	S	date_modified = “2008-12-23T20:35:00Z”	The date on which the file was modified. See chapter 3.2.4 - on time format. If this attribute is used for the first time or modified, a new entry needs to be added to the “history” attribute.
history	S	history = “2014-03-27T23:46:36Z - timeOffsetPP: TIME dimension and time_coverage_start/end global attributes have been applied the following offset : -10 hours.”	Provides an audit trail for modifications to the original data. It should contain a separate line for each modification, with each line beginning with a timestamp and including user name, modification name and modification arguments.

	comment	S	comment ="Geospatial vertical min information has been computed using the Gibbs-SeaWater toolbox (TEOS-10) v3.02 from latitude and relative pressure measurements"	Miscellaneous information about the data or methods used to produce it. Any free-format text is appropriate
	source	S	source = "Radar Observation"	Method of production of the original data
Non-CF attribute	instrument	S	instrument = "WETLABS WQM"	Make and model of the instruments from which the data has been collected.
Non-CF attribute	instrument_serial_number	S	instrument_serial_number = "5124"	Serial number of the instrument which has produced the dataset.
	references	S	references = "http://www.imos.org.au"	Published or web-based references that describe the data or the methods used to produce the data. Include a reference to IMOS and a project-specific reference if appropriate. Multiple references should be separated with a semicolon ";".
Non-CF attribute	site_code	S	site_code = "NRSMAI"	Unique site code within IMOS project. A site refers to a nominal location around which (within a certain radius) repeated measurements are performed to produce a time-series dataset.
Non-CF attribute	site	S	site = "Maria Island National Reference Station, TAS"	Site description.

Non-CF attribute	platform_code	S	platform_code = “NRSMAI-SubSurface”	Unique platform code within IMOS project. The platform codes are listed in Reference Table 3 of the File Naming Convention document. A platform refers to the actual structure to which the instrument or sensor is attached.
Non-CF attribute	platform	S	platform = “Subsurface mooring at Maria Island National Reference Station, TAS site”	Platform description. They are listed in Reference Table 3 of the File Naming Convention document.
Non-CF attribute	cdm_data_type	S	cdm_data_type = “Station”	The “cdm_data_type” attribute gives the Unidata CDM (Common Data Model) data type used by THREDDS. E.g. “Point”, “Trajectory”, “Station”, “Radial”, “Grid”, “Swath”.
Non-CF attribute	keywords	S	keywords = “Oceans > Ocean Circulation > Ocean Currents , Oceans > Ocean Waves > Significant Wave Height ,…”	A comma separated list of keywords coming from the keywords_vocabulary.
Non-CF attribute	keywords_vocabulary	S	keywords_vocabulary = “NASA/GCMD Earth Science Keywords”	Identifies the controlled keyword vocabulary used to specify the values within the attribute "keywords".

Non-CF attribute	metadata	S	metadata = " http://....."	URL to the metadata record corresponding to the netCDF file. eMII is considering adding this information to the data files as part of eMII data processing. Facilities would not be required to complete these fields when submitting data.
Non-CF attribute	sensorML	S	sensorML = " http://....."	Link to the sensorML record corresponding to the netCDF file. eMII is considering adding this information to the data files as part of eMII data processing. Facilities would not be required to complete these fields when submitting data.
	institution_address	S	institution_address = "Oceanography laboratory, School of Mathematics and Statistics, University of New South Wales, Sydney NSW 2052"	Address of the institute or facility where the original data was produced.
	institution_postal_address	S	institution_postal_address = "University of New South Wales, Sydney NSW 2052"	Postal address of the institute or facility where the original data was produced.
Non-CF attribute	file version	S	file_version = "Level 0 - Raw data"	Information about the file version of the file. Three levels are possible at the moment: - Level 0 - Raw data - Level 1 - Quality Controlled data - Level 2 - Derived product

Non-CF attribute	file_version_quality_control	S	file_version_quality_control = “Data in this file has not been quality controlled”	Description of the level of Quality Control applied to the data. See section **Error! Reference source not found.**for more information and examples.
Non-CF attribute	quality_control_log	S	quality_control_log = "imosImpossibleDateQC(dateMin=01/01/2007, dateMax=15/07/2014) did not fail on any TIME sample.\nimosImpossibleLocationSetQC(distanceKmPlusMinusThreshold=2.5) did not fail on any LATITUDE sample.\nimosImpossibleLocationSetQC(distanceKmPlusMinusThreshold=2.5) did not fail on any LONGITUDE sample....”	QC procedures applied with their specific parameters and results.
Non-CF attribute	**Where**			
	geospatial_lat_units	S	geospatial_lat_units = “degrees_north”	Units used for geospatial_lat_min/max attributes.
	geospatial_lon_units	S	geospatial_lon_units = “degrees_east”	Units used for geospatial_lon_min/max attributes.
	geospatial_vertical_units	S	geospatial_vertical_units = “metres”	Units used for geospatial_vertical_min/max attributes.
Non-CF attribute	**When**			

	local_time_zone	N	local_time_zone = 10	Local time zone at the location of the dataset. See section 3.2.4 - on time format. If local time does not fall into one zone for the full dataset, do not use this attribute.
Non-CF attribute	**Who**			
	author_email	S	author_email = “info@emii.org.au”	NetCDF file author contact e-mail address
	principal_investigator_email	S	principal_investigator_email = “john.doe@utas.edu.au”	Principal Investigator e-mail address
	institution_references	S	institution_references = “http://imos.org.au/emii.html”	References that describe the data provider institution, the place to find all information on the dataset (web-based, i.e. give URLs). Multiple references should be separated with a semicolon “;”.
	How			
	lineage	S	lineage = “Data were processed according to standard ANMN-NRS procedures before conversion to netCDF. See link for details : http://help.aodn.org.au/help/sites/help.aodn.org.au/files/ANMN%20CTD%20Processing%20Procedures.pdf”	Information about how the data has been produced and processed, modified.

3.2.4 -Date and Time formats

All time values in IMOS netCDF files will be recorded as Coordinated Universal Time (UTC, for most purposes equivalent to Greenwich Mean Time).

Whenever time information is given in the global attributes, it will be formatted as a string according to the ISO 8601 standard (International Organization for Standardization, 2009): "YYYY-MM-DDThh:mm:ssZ" (i.e. year – month – day "T" hour : minute : second "Z") The "Z" indicates the time zone is (zero offset from) UTC. If higher resolution than seconds is needed, any number of decimal digits (".s") for the seconds is acceptable: "YYYY-MM-DDThh:mm:ss.sZ". Examples of the time format are shown below.

2005-10-24T08:00:00Z

2008-01-01T22:50:02.03Z

The representation of time as a numerical variable is described under the TIME variable chapter 3.4.1.1 -.

The global attribute 'local_time_zone' gives the time zone at the location where the measurements were collected. This allows the UTC times in the file to be converted into local time, which is important in considering many biological processes and phenomena that depend on the diurnal cycle.

The local time zone will be recorded as an offset in hours from UTC. For example Australian Eastern Standard Time is represented as 10, meaning 10 hours ahead of UTC.

Offsets from local to UTC time for Australian time zones can be found online.

The global attribute 'local_time_zone' should be used only when all data points in a dataset are from the same time zone. If time zone changes during the dataset (e.g. moving point measurements on a ship of opportunity) then do not use this global attribute. Instead, advanced users may choose to create a user-defined variable called 'local_time_zone'. If local time zone is not defined in the dataset, it will be calculated by data users from the latitude, longitude and UTC time variables.

3.2.5 -Processing level

Two attributes <file_version> and <file_version_quality_control> respectively describe the title and definition of level of processing and Quality Control (QC) found in the dataset.

Three possibilities are available for these two attributes:

Global attribute <file_version>	Global attribute <file_version_quality_control>
Level 0 - Raw data	Raw data is defined as unprocessed data and data products that have not undergone quality control. The data may be in engineering or physical units, time and location details can be in relative units and values can be pre-calibration measurements.
Level 1 – Quality Controlled data	Quality controlled data have been through quality assurance procedures such as automated routines and sensor calibration or visual inspection and flag of obvious errors. The data are in physical units using standard SI metric units with calibration and other pre-processing routines applied, all time and location values are in absolute coordinates to comply with standards and datum. Data includes flags for each measurement to indicate the estimated quality of the measurement. Metadata exists for the data or for the higher level dataset that the data belongs to. This is the standard IMOS data level and is what should be made available to eMII and to the IMOS community.
Level 2 – Derived Products	Derived products require scientific and technical interpretation. Normally these will be defined by the community that collects or utilises the data.

3.2.6 -Global Attributes added by the data provider

The global attributes listed in the table in section 3.2.2 - are most important to define a dataset as clearly as possible. However, this list will not in all cases be exhaustive and eMII requests that other meaningful global attributes be used where necessary.

It is possible to add global attributes to meet specific facility needs. New attributes will need to be self defined, including a description and an example of how it is used. User-defined global attributes should be added to the existing list (appropriate appendix section) in the next version of the IMOS NetCDF Conventions document.

An example of a ‘facility defined’ global attribute and supporting information is below:

This example can be used by the ACORN facility to illustrate the kind of data and the type of radar used to produce the data. The prefix “ssr” added to each attribute means “sea surface radar”.

ssr_Data_Type = “Range_Time_Series”

ssr_Radar = “Helzel/WERA”

3.3 - Dimensions

NetCDF file dimensions provide information on the size of the data variables. An unlimited dimension will make extension (new data added to an existing file) and aggregation (distinct files piled together into a single one) possible later if needed along this dimension. A dimension of size 1 can also be replaced by a scalar variable. The example in Table 3 allows for measurements at an unlimited number of time steps, at five different static depths.

Requirements are described further in the section 3.4.1 -.

Table 3 An example list of Dimensions for an IMOS netCDF file

Name	Example	Comment
TIME	TIME = unlimited	Number of time steps
DEPTH	DEPTH = 5	Number of depth levels

3.4 - Variables

NetCDF variables include data measured by instruments, parameters derived from the primary measurements and coordinate variables, which may be nominal values such as values for depth for instruments that do not directly record depth. Variables are also used to store quality flags associated to a measurement, and other metadata that is not applicable to all the data in a file. Ways to represent each type of variable in an IMOS netCDF file are described in the sub-sections below. Defined variable names are listed in chapter 5.1 -. Each variable has a specific set of attributes, some of which are mandatory.

In the tables below for variable attributes, the “Type” values are **S** for string, **N** for numeric (byte, short, long, integer, float or double), **D** for the type of the data variable and **Q** for the type of the quality control data variable. **Mandatory attributes** are marked **in bold**.

3.4.1 -Spatio-temporal variables

The spatio-temporal variables locate the data in time and space. For this purpose, they have an “axis” attribute to indicate that they represent either latitude (axis = “X”), longitude (“Y”), depth/height (“Z”) or time (“T”). Any measured parameter can be located in space and time by listing the relevant spatio-

temporal variables in its coordinates attribute. The use of a common set of spatial and temporal units and measures is the basic requirement to be able to integrate the various data collected by the IMOS project.

These variables can be coordinate variables[1] (representing an independent dimension of the data in the file), auxiliary coordinate variables[2] (dependent on one or more dimensions in the file) or scalar coordinate variables[3] depending on the CF feature type template chosen. For more details on ways to associate data variables with their spatio-temporal coordinates, see chapters 5 and 9 of the CF conventions document.

3.4.1.1 - Time

In a netCDF file, time is represented numerically as an interval (e.g. number of days or hours) from a reference time. For IMOS data, eMII recommends using a decimal number of days since the ARGO reference time of 1st of January 1950 at 00:00:00 UTC. In these conditions, using single precision would only achieve a 30s resolution so we recommend that any time measurement is stored in double precision using the type Double.

The following table presents the attributes used to describe the time variable.

Table 4 List of attributes defining the TIME variable for IMOS netCDF files

Attributes	Type	Example	Comment
standard_name	S	standard_name="time"	A CF standard name that references a description of a variable's content in the standard name table
long_name	S	long_name = "time"	A descriptive name that indicates a variable's content.

[1] It is a one-dimensional variable with the same name as its dimension [e.g., TIME(TIME)], and it is defined as a numeric data type with values that are ordered monotonically. Missing values are not allowed in coordinate variables.

[2] Any netCDF variable that contains coordinate data, but is not a coordinate variable (see above). Unlike coordinate variables, there is no relationship between the name of an auxiliary coordinate variable and the name(s) of its dimension(s).

[3] A scalar variable that contains coordinate data. Functionally equivalent to either a size one coordinate variable or a size one auxiliary coordinate variable.

	units	S	units = “days since 1950-01-01 00:00:00 UTC”	This is eMII’s recommended unit and reference time for IMOS netCDF files. Please contact eMII if you require help with this conversion.
	axis	S	axis = “T”	Identifies time axes
	valid_min	D	valid_min = 0	Smallest valid value of a variable
	valid_max	D	valid_max = 90000.0	Largest valid value of a variable
	_FillValue	D	_FillValue = 999999.0	A value used to represent missing or undefined data[4]. Cannot be used for coordinate variables. Required if there could be missing values in the data.
	calendar	S	calendar = “gregorian”	Calendar used for encoding time axes. See Eaton et. al. 2009 for clarification.
	comment	S	comment = “…….”	Miscellaneous information about the data or methods used to produce it.
Non-CF attribute	uncertainty	N	uncertainty = 0.00001	Overall measurement uncertainty. Choose appropriate value. See section 3.4.4.2 -.
Non-CF attribute	local_time_zone	N	local_time_zone = 10	Local time zone. See chapter 3.2.4 -. If local time does not fall into one zone for the full dataset, do not use this attribute.

See APPENDIX 1: example netcdf file.

[4] We ask that NaN “not a number” value shouldn’t be used. Instead use a decimal value e.g. _FillValue of 999999.0.

3.4.1.2 - Horizontal coordinates

Horizontal coordinates (Latitude and Longitude) in an IMOS netCDF file will be specified in decimal degrees relative to the WGS84 coordinate reference system, with locations south of the equator having negative Latitude and locations west of zero degrees of Longitude having negative Longitude.

Using single precision would only achieve at worst an 11m resolution while modern GPS can provide <1m resolution. We recommend that any measurement of geographic coordinates is stored in double precision using the type Double.

The table below presents the attributes used to describe the variables LATITUDE and LONGITUDE.

Table 5 List of attributes that define the LATITUDE and LONGITUDE variables for IMOS netCDF files

Attributes	Type	Example	Comment
standard_name	S	standard_name = “latitude” or standard_name = “longitude”	A CF standard name that references a description of a variable’s content in the standard name table
long_name	S	long_name = “latitude” or long_name = “longitude”	A descriptive name that indicates a variable’s content. This name is the IMOS long name given in chapter 5.1 -.
units	S	units = “degrees_north” (LATITUDE) or units = “degrees_east” (LONGITUDE)	Latitude unit: degrees north ; southern latitudes are negative Longitude unit: degrees east ; western longitudes are negative
axis	S	axis = “ Y ” (LATITUDE) or axis = “ X ” (LONGITUDE)	Identifies type of spatial axis

valid_min	D	valid_min = -90 (LATITUDE) valid_min = -180 (LONGITUDE)	Smallest valid value of a variable
valid_max	D	valid_max = 90 (LATITUDE) valid_min = 180 (LONGITUDE)	Largest valid value of a variable
_FillValue	D	_FillValue = 999999.0	A value used to represent missing or undefined data[5]. Cannot be used for coordinate variables. Required if there could be missing values in the data
comment	S	comment = " ……."	Miscellaneous information about the data or methods used to produce it.
uncertainty	N	uncertainty = 0.001	Overall measurement uncertainty. Choose appropriate value. See section 3.4.4.2 -.
reference_datum	S	reference_datum = "WGS84 coordinate reference system"	Text description of the geographic reference datum for the variable

Non-CF attribute

Non-CF attribute

See APPENDIX 1: example netcdf file.

3.4.1.3 - Vertical coordinates

For any vertical coordinate, variable attributes must define a reference point or datum (attribute "reference_datum"), the direction of increasing values (attribute "positive", up or down) and the unit of measure (attribute "units"). Four datums are recognised:

-Mean Sea Level (MSL),

-sea surface,

-sea bottom,

-sensor.

The time and location of the instrument will need to be included to allow for tide corrections. When necessary, vertical measurements should be converted into one of the acceptable datums.

For example: depth may be recorded as metres below MSL, positive down.

Depth and height should be measured in metres or other SI units. Pressure measurements should be recorded in a separate parameter. It is not permissible to label a pressure measurement as “depth” or “height”.

The following table presents the attributes used to describe any depth or height variable.

Table 6 List of attributes that define any depth or height variable for IMOS netCDF files

Attributes	Type	Example	Comment
standard_name	S	standard_name = “depth” or “height”	A CF standard name that references a description of a variable’s content in the standard name table
long_name	S	long_name = “depth” or “height”	A descriptive name that indicates a variable’s content. This name is the IMOS long name given in chapter 5.1 -
units	S	units = “ m ”	Usually “m” for metres.
axis	S	axis = “ Z ”	Identifies vertical axis
positive	S	positive = “down ” (depth) or “up” (height)	Direction of increasing vertical coordinate value.
valid_min	D	valid_min = 0	Smallest valid value of the variable

[5] We ask that NaN “not a number” value shouldn’t be used. Instead use a decimal value e.g. _FillValue of 999999.0.

	valid_max	D	valid_max = 12000	Largest valid value of the variable
	_FillValue	D	_FillValue = -99999.0	A value used to represent missing or undefined data[6]. Cannot be used if DEPTH/HEIGHT is a dimension. Required if there could be missing values in the data.
	comment	S	comment = "depthPP: Depth computed using the SeaWater toolbox from latitude and relative pressure measurements…"	Miscellaneous information about the data or methods used to produce it.
Non-CF attribute	uncertainty	N	uncertainty = 0.05	Overall measurement uncertainty. Choose appropriate value. See section 3.4.4.2 -.
Non-CF attribute	**reference_datum**	S	reference_datum = "Mean Sea Level (MSL)"	Text description of the reference datum for the variable

See APPENDIX 1: example netcdf file.

3.4.2 -Data variables

IMOS recommended variable names are listed in chapter 5.1 -. For example, TEMP represents the sea water temperature and PSAL represents the sea water salinity. Variable names should begin with a letter and be composed of letters, digits and underscores.

In some cases, two instruments may measure the same variable (e.g. wind speed measured by two anemometers mounted on the same vessel). In these cases, the second instance of a variable should be identified with the suffix '_2' (e.g. "WSPD" and "WSPD_2"). Several variable attributes can be used to

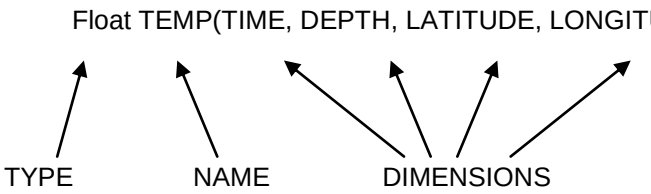
[6] We ask that NaN "not a number" value shouldn't be used. Instead use a decimal value e.g. _FillValue of 999999.0.

specify the differences, including comments, descriptive attributes (sensor_depth, sensor_height) and long names. Two anemometers might be distinguished in their long names as “wind_speed_starboard” and “wind_speed_port”.

The definition of a variable in a netCDF file has three components: type, name and dimensions.

CF says: “If any or all of the dimensions of a variable have the interpretations of "date or time" (T), "height or depth" (Z), "latitude" (Y), or "longitude" (X) then it is recommended, but do not required, that those dimensions appear in the relative order T , then Z , then Y , then X in the CDL definition corresponding to the file. All other dimensions should, whenever possible, be placed to the left of the spatiotemporal dimensions”.

Example for the sea water temperature output by a 3D model over a time period:



The following table presents the attributes used to describe a data variable.

Table 7 List of data variables attributes for IMOS netCDF files

Attributes	Type	Example	Comment
standard_name	S	standard_name = “sea_surface_temperature”	A CF standard name that references a description of a variable’s content in the CF standard name table.
units	S	units = “Celsius”	Unit of measure
_FillValue	D	_FillValue = 999999	A value used to represent missing or undefined data[7]. Required if there could be missing values in the data.

[7] We ask that NaN “not a number” value shouldn’t be used. Instead use a decimal value e.g. _FillValue of 999999.0.

long_name	S	long_name = “sea_surface_temperature”	A descriptive name that indicates a variable’s content. This name is the IMOS long name given in chapter 5.1 -. Please contact eMII regarding any parameters that don’t appear in the table
coordinates	S	coordinates = "TIME LATITUDE LONGITUDE DEPTH" ;	A blank-separated list of the names of the relevant variables that include spatio-temporal coordinate information.
valid_min valid_max	D	valid_min = -2.0 valid_max = 40	Range of values for valid data
add_offset	N	add_offset = 25	If present for a variable, this number is to be added to the data after it is read by an application. If both scale_factor and add_offset attributes are present, the data are first scaled before the offset is added.
scale_factor	N	scale_factor = 0.01	If present for a variable, the data are to be multiplied by this factor after the data are read by an application.
applied_offset	N	applied_offset = -10.1325	If present for a variable, this offset has been added to the original data to correct it.
original_units	S	original_units = “mg/l”	Original units of a variable’s content in the original instrument file. Dissolved

Non-CF attribute

Non-CF attribute

				oxygen concentration for example can be expressed in many units but umol l^{-1} is IMOS preferred units for dissemination.
Non-CF attribute	original_name	S	original_name = “oxsolMg/L”	Original name of a variable in the original instrument file.
Non-CF attribute	sensor_serial_number	S	sensor_serial_number = “DO142”	Serial number of the sensor which collected the data of this variable.
	comment	S		Miscellaneous information about the this variable or methods used to produce it
	history	S		As for global attribute history, but specific to this variable.
	references	S		References that describe the data or methods used to produce it. Multiple references should be separated with a semicolon.
	ancillary_variables	S	ancillary_variables = “TEMP_quality_control TEMP_uncertainty”	Blank-separated list of variables that contain closely associated data, e.g. the measurement uncertainties of instrument data. See section 3.4.4 -.
Non-CF attribute	sensor_depth	N	sensor_depth = 0	Nominal sensor depth(s) in metres positive down.
Non-CF attribute	sensor_height	N	sensor_height = 2	Nominal sensor height(s) in metres positive up.

Non-CF attribute	observation_type	S	observation_type = “measured”	Type of observation. If for example, the variable is measured or calculated.
Non-CF attribute	uncertainty	N	uncertainty = 0.001	Overall measurement uncertainty, if constant. See section 3.4.4.2 -.
Non-CF attribute	accuracy	N	accuracy = 0.01	Nominal sensor accuracy. See section 3.4.4.2 -.
Non-CF attribute	precision	N	precision = 0.01	Nominal sensor precision. See section 3.4.4.2 -.
Non-CF attribute	resolution	N	resolution = 0.01	Nominal resolution of this data parameter. See section 3.4.4.2 -.
	cell_methods	S	cell_methods = “point”	Records the method used to derive data that represents cell values. See section 5.3 -

See APPENDIX 1: example netcdf file.

3.4.3 -Variable attributes added by data provider

Additional variable attributes can be defined by the data provider (in consultation with eMII). Such attributes will be incorporated into the next version of this document.

3.4.4 -Ancillary variables

When one variable provides metadata about the individual values of another variable it may be desirable to express this association by providing a link between the variables. For example, instrument data may have associated measures of uncertainty or quality control flags. The attribute “ancillary_variable” is used to express these types of relationships.

The use of ancillary variables in the context of data Quality Control and uncertainty are described in sections 3.4.4.1 - and.3.4.4.2 -.

3.4.4.1 - Quality control (QC)

Quality control involves some sort of assessment of the data to identify data points or even data sets which have errors that limit their use. The basic approach used by IMOS is to keep all of the data but to flag data or data sets that do not meet the quality assessment standards of data collectors / principal investigators. This section describes how to represent this data quality information in an IMOS netCDF file.

3.4.4.1.1 - Quality Control sets used by the IMOS project

The attribute "quality_control_conventions**"** will enable users to define which set of quality control (QC) flags was applied to the dataset. Please see chapter 5.2 -. Additional QC sets may be added in future versions of this document.

3.4.4.1.2 - Definition of quality control variables and attributes

Quality flags for the data in a variable <PARAM> should be described by an ancillary variable named "<PARAM>_quality_control".

The following table lists all the attributes used to define a Quality Control variable. It also includes an example using the quality control set 1 (IMOS standard flags).

Table 8 List of attributes used to define a Quality Control variable

Attributes	Type	Example	Comment
long_name	S	long_name = "quality flag for sea_surface_temperature"	Non-standardised name of variable
standard_name	S	standard_name = "sea_surface_temperature status_flag"	Standardised name (status_flag suffix) of QC variable using the CF convention

quality_control_conventions	S	quality_control_conventions =”IMOS standard flags”	Name of the Quality Control convention used. See Reference table A.
_FillValue	D	_FillValue = 99b	Value used to represent missing QC flags
flag_values	D	flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b	List of flag values used.
flag_meanings	S	flag_meanings = "No_QC_performed Good_data Probably_good_data Bad_data_that_are_potentially_correctable Bad_data Value_changed Not_used Not_used Not_used Missing_value"	The meaning of each flag (in the same order as flag_values).
quality_control_global_conventions	S	quality_control_global_conventions = "Argo reference table 2a (see http://www.cmar.csiro.au/argo/dmqc/ user_doc/QC_flags.html), applied to data in position only (between global attributes time_deployment_start and time_deployment_end)"	Convention used to describe the global quality of a variable.
quality_control_global	S	quality_control_global = "A"	Global quality control value. See 5.2.2.2 -

See APPENDIX 1: example netcdf file.

3.4.4.2 - Uncertainty, accuracy, precision and resolution

The term uncertainty is here defined as “the parameter, associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand” (Underwood, 2008).

The document "IMOS Data Streams and their Uncertainties" (Underwood, 2008) contains a calculation or estimation of the uncertainty for each data stream that is provided by IMOS..

3.4.4.2.1 - Implementation in IMOS

If the overall measurement uncertainty for a variable <PARAM> is reasonably well-known, it must be provided in the attributes. If it is constant is should be provided in the attribute <PARAM>:uncertainty. If not constant it should be provided in a variable of its own, called <PARAM>_uncertainty. The standard name for this variable is formatted as: "<parameter_standard_name> standard_error" (e.g. TEMP_uncertainty:standard_name = "sea_surface_temperature standard_error")

If it is impossible to estimate the overall measurement uncertainty, the attribute <PARAM>:accuracy can be set to the nominal sensor accuracy. Accuracy characterises how close the measurement of a quantity is to the value of that quantity (systematic errors reduce accuracy).

The attributes <PARAM>:precision and <PARAM>:resolution contain the sensor precision and resolution if defined. Precision characterises the level of agreement between repeated measurements of a quantity under unchanged conditions (random errors reduce precision). Resolution is a limit on the precision of a measurement imposed by the amount of information recorded (e.g. number of decimal places, or number of measurements in a time interval).

3.4.4.2.2 - Example

This example is extracted from the "IMOS Data Streams and their Uncertainties" document (Underwood, 2008).

A temperature measurement may be given as "20.12 degrees Celsius with a 95% confidence of 0.01 degree Celsius". To rephrase this, there are 5 chances in one hundred that the real temperature (the measurand) was outside the range 20.12 C +- 0.01 C.

In a netCDF file, the uncertainty on this temperature measurement will appear as:

TEMP:uncertainty = 0.01

4 - IMOS FILE NAMING CONVENTION

NetCDF files will be named according to the IMOS NetCDF File Naming Convention document. See APPENDIX 3: IMOS File Naming Convention.

5 - REFERENCE TABLES

5.1 - IMOS parameter dictionary

The IMOS parameter dictionary seeks to list recommended netCDF variable names, long_name, standard_name and units attributes to be used.

The most up to date list of parameter names, standard names (or long names for non-CF parameters) and units can be found on the IMOS Toolbox GitHub repository. This list is not exhaustive and will continue to expand and evolve. Ultimately, it will constitute an IMOS data parameter dictionary. The standard names used in the IMOS parameter dictionary are taken from the CF standard names.

Non-CF long names and variable names are derived from the following sources:

- a list of parameter names available on the WOCE website using GF3 codes (WOCE, 2009).
- a parameter dictionary available on the OceanSites data format reference manual (OceanSites, 2008).

Non-CF parameters (with no CF standard name) should be described using only the attribute long_name.

All units defined for the parameters must comply with Udunits (Unidata Program Centre of the University Corporation for Atmospheric Research, 2008) as implemented by the CF standard.

5.2 - Quality control flags

Quality control (QC) flags are added to a file by various procedures to indicate the quality of individual data values.

The attribute “quality_control_set” enables the user to define which Quality Control flags set was used in the dataset. Please see section 3.4.4.1 - for definitions of Quality Control sets.

If your facility is using a different set of quality control codes please supply eMII with the details. If appropriate, we will incorporate your codes into the IMOS convention and create a QC set that meets your needs.

Reference Table A : List of QC flags sets used in the IMOS project

Set Number	Description
1	IMOS standard flags (GTSPP data quality codes)
2	ARGO quality control procedure
3	BOM (SST and Air-Sea flux) quality control procedure
4	WOCE quality control procedure (Multidisciplinary Underway Network – CO_2 measurements)

5.2.1 -Set 1 - IMOS standard flags

Reference Table B : IMOS standard flags

Flag Value	Meaning	Description
0	No QC performed	The level at which all data enter the working archive. They have not yet been quality controlled
1	Good data	Top quality data in which no malfunctions have been identified and all real features have been verified during the quality control process

2	Probably good data	Good data in which some features (probably real) are present but these are unconfirmed. Code 2 date are also data in which minor malfunctions may be present but these errors are small and/or can be successfully corrected without seriously affecting the overall quality of the data.
3	Bad data that are potentially correctable	Suspect data in which unusual, and probably erroneous features are observed
4	Bad data	Obviously erroneous values are observed
5	Value changed [8]	Altered by a QC Centre, with original values (before the change) preserved in the history record of the profile
6	Not used	Flag 6 is reserved for future use
7	Not used	Flag 7 is reserved for future use
8	Not used	Flag 8 is reserved for future use
9	Missing value	Indicates that the element is missing

5.2.2 -Set 2 - ARGO quality control procedure

5.2.2.1 - ARGO measurement flag scale

Reference Table C : ARGO measurement flag scale

Flag Value	Meaning	Real-time comment	Delayed-mode comment
0	No QC was performed	No QC was performed	No QC was performed

[8] Where data values must be changed (e.g. smoothing of data sets) we strongly prefer that the original data be retained and an additional variable be added to accommodate the interpolated/corrected data values.

1	Good data	All ARGO real-time QC tests passed	The adjusted value is statistically consistent and a statistical error estimate is supplied
2	Probably good data	Probably good data	Probably good data
3	Bad data that are potentially correctable	Argo QC tests (15, 16 or 17, see Carval et al 2008) failed and all other real-time QC tests passed. These data are not to be used without scientific correction. A flag 3 may be assigned by an operator during additional visual QC for bad data that may be corrected in delayed mode	An adjustment has been applied, but the value may still be bad
4	Bad data	Data have failed one or more of the real-time QC tests, excluding Test 16 (see Carval et al 2008). A flag 4 may be assigned by an operator during additional visual QC for bad data that are not correctable	Bad data. Not adjustable
5	Value changed [9]	Value changed	Value changed
6	Not used	Not used	Not used
7	Not used	Not used	Not used
8	Interpolated value	Interpolated value	Interpolated value

[9] Where data values must be changed we strongly prefer that the original data be retained and an additional variable be added to accommodate the interpolated/corrected data values.

9	Missing value	Missing value	Missing value

5.2.2.2 - ARGO profile quality flags

Argo profile quality flags (A to F) are defined as the percentage of levels (N) with good data, where:

- QC flag values of 1, 2, 5 or 8 are counted as GOOD data
- QC flag values of 9 (missing) are NOT USED in the computation
- All other QC flag values are counted as BAD data

The computation should be taken from <PARAM>_ADJUSTED_QC if available and from <PARAM>_QC otherwise (Carval et al 2008).

This could also be applied to any type of data, not only profile data.

Reference Table D : ARGO profile quality flags

Flag	Meaning
" " (blank)	No QC performed
A	N = 100%; All profile levels contain good data
B	75% <= N < 100%
C	50% <= N < 75%
D	25% <= N < 50%
E	0% <= N < 25%
F	N = 0%; No profile levels have good data

Example:

A TEMP profile has 60 levels (3 levels contain missing values)

- 45 levels are flagged as 1
- 5 levels are flagged as 2
- 7 levels are flagged as 4

- 3 levels are flagged as 9 (missing)

Percentage of good levels = ((45+5)/57)*100 = 87.7%

TEMP_quality_control:quality_control_global = "B"

5.2.3 -Set 3 - BOM quality control procedure (SST and Air-Sea fluxes)

The following table summarises the different flags used by the Bureau of Meteorology to qualify the quality for different datasets, particularly SST and Air-Sea fluxes (Verein 2008).

Reference Table E : BOM Quality Control procedure flags (SST and Air Sea Fluxes)

Flag	Purpose
B	Value out of bounds
C	Time not sequential
D	Failed T, Tw and Td tests
E	Failed True wind recomputation test
F	Platform velocity unrealistic
G *	Value exceeds threshold
H **	Discontinuity
J	Erroneous value
L	Value located over land
M	Instrument malfunction
Q	Pre-flagged as suspect
S	Spike in data (visual)
T	Time duplicate
U *	Suspect data (statistical)
V *	Step in data (statistical)
X *	Spike in data (statistical)
Z	Value passed all test

Note: * - applied for SST, ** - applied for time

5.2.4 -Set 4 - WOCE quality control procedure (Multidisciplinary Underway Network – CO_2 measurements)

Reference Table F : WOCE quality control procedure flags (CO_2 measurements)

Flag	Meaning
2	good
3	questionable
4	bad

If data is flagged as questionable (flag number 3), the variable SUBFLAG is used to add more information.

Table FF: SUBFLAG variable for questionable measurements

Flag	Meaning
1	Outside of standard range
2	questionable/interpolated SST (Sea Surface Temperature)
3	questionable EQU temperature
4	Anomalous (EQU T-SST) (+- 1 C)
5	questionable sea-surface salinity
6	questionable pressure
7	low EQU gas flow
8	questionable air value
10	other, water flow

References: "Pierrot,D. et al. 2009, Recommendations for Autonomous Underway pCO2 Measuring Systems and Data Reduction Routines, Deep-Sea Research II, doi:10.1016/j.dsr2.2008.12.005"

5.3 - Cell methods

CF Cell methods are applied in generating the parameter value for a cell, particularly for gridded data sets.

In the Units column, u indicates the units of the physical quantity before the method is applied.

Reference Table G : List of different cell methods, derived from the CF convention

Cell method	Units	Description
point	u	The data values are representative of points in space or time (instantaneous). This is the default method for a quantity that is intensive with respect to the specified dimension.
sum	u	The data values are representative of a sum or accumulation over the cell. This is the default method for a quantity that is extensive with respect to the specified dimension
maximum	u	Maximum
median	u	Median
mid_range	u	Average of the maximum and minimum
minimum	u	Minimum
mean	u	Mean (average value)
mode	u	Mode (most common value)
standard_deviation	u	Standard deviation
variance	u^2	Variance

6 - REFERENCES

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APPENDIX 1: EXAMPLE NETCDF FILE

This is an example IMOS formatted netCDF file for ANMN timeseries temperature and pressure logger data.

```
netcdf IMOS_ANMN-NSW_TZ_20110616T230000Z_PH100_FV01_PH100-1106-Aqualogger-520PT-104_END-20110902T130000Z_C-20150225T011055Z {
dimensions:
    TIME = 22345 ;
variables:
    double TIME(TIME) ;
        TIME:standard_name = "time" ;
        TIME:long_name = "time" ;
        TIME:units = "days since 1950-01-01 00:00:00 UTC" ;
        TIME:calendar = "gregorian" ;
        TIME:axis = "T" ;
        TIME:valid_min = 0. ;
        TIME:valid_max = 90000. ;
    double LATITUDE ;
        LATITUDE:standard_name = "latitude" ;
        LATITUDE:long_name = "latitude" ;
        LATITUDE:units = "degrees_north" ;
        LATITUDE:axis = "Y" ;
        LATITUDE:reference_datum = " WGS84 coordinate reference system" ;
        LATITUDE:valid_min = -90. ;
        LATITUDE:valid_max = 90. ;
    double LONGITUDE ;
        LONGITUDE:standard_name = "longitude" ;
        LONGITUDE:long_name = "longitude" ;
        LONGITUDE:units = "degrees_east" ;
        LONGITUDE:axis = "X" ;
        LONGITUDE:reference_datum = "WGS84 coordinate reference system" ;
        LONGITUDE:valid_min = -180. ;
        LONGITUDE:valid_max = 180. ;
    float NOMINAL_DEPTH ;
        NOMINAL_DEPTH:standard_name = "depth" ;
        NOMINAL_DEPTH:long_name = "nominal depth" ;
        NOMINAL_DEPTH:units = "metres" ;
        NOMINAL_DEPTH:axis = "Z" ;
        NOMINAL_DEPTH:positive = "down" ;
        NOMINAL_DEPTH:reference_datum = "sea surface" ;
        NOMINAL_DEPTH:valid_min = -5.f ;
        NOMINAL_DEPTH:valid_max = 12000.f ;
    float TEMP(TIME) ;
        TEMP:coordinates = "TIME LATITUDE LONGITUDE NOMINAL_DEPTH" ;
        TEMP:standard_name = "sea_water_temperature" ;
        TEMP:long_name = "sea_water_temperature" ;
```

TEMP:units = "Celsius" ;
TEMP:valid_min = -2.5f ;
TEMP:valid_max = 40.f ;
TEMP:_FillValue = 999999.f ;
TEMP:ancillary_variables = "TEMP_quality_control" ;
byte TEMP_quality_control(TIME) ;
TEMP_quality_control:long_name = "quality flag for sea_water_temperature" ;
TEMP_quality_control:standard_name = "sea_water_temperature status_flag" ;
TEMP_quality_control:_FillValue = 99b ;
TEMP_quality_control:quality_control_conventions = "IMOS standard flags" ;
TEMP_quality_control:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ;
TEMP_quality_control:flag_meanings = "No_QC_performed Good_data Probably_good_data Bad_data_that_are_potentially_correctable Bad_data Value_changed Not_used Not_used Not_used Missing_value" ;
TEMP_quality_control:quality_control_global_conventions = "Argo reference table 2a (see http://www.cmar.csiro.au/argo/dmqc/user_doc/QC_flags.html), applied on data in position only (between global attributes time_deployment_start and time_deployment_end)" ;
TEMP_quality_control:quality_control_global = "A" ;
float PRES(TIME) ;
PRES:coordinates = "TIME LATITUDE LONGITUDE NOMINAL_DEPTH" ;
PRES:standard_name = "sea_water_pressure" ;
PRES:long_name = "sea_water_pressure" ;
PRES:units = "dbar" ;
PRES:valid_min = -5.f ;
PRES:valid_max = 12000.f ;
PRES:_FillValue = 999999.f ;
PRES:ancillary_variables = "PRES_quality_control" ;
byte PRES_quality_control(TIME) ;
PRES_quality_control:long_name = "quality flag for sea_water_pressure" ;
PRES_quality_control:standard_name = "sea_water_pressure status_flag" ;
PRES_quality_control:_FillValue = 99b ;
PRES_quality_control:quality_control_conventions = "IMOS standard flags" ;
PRES_quality_control:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ;
PRES_quality_control:flag_meanings = "No_QC_performed Good_data Probably_good_data Bad_data_that_are_potentially_correctable Bad_data Value_changed Not_used Not_used Not_used Missing_value" ;
PRES_quality_control:quality_control_global_conventions = "Argo reference table 2a (see http://www.cmar.csiro.au/argo/dmqc/user_doc/QC_flags.html), applied on data in position only (between global attributes time_deployment_start and time_deployment_end)" ;
PRES_quality_control:quality_control_global = "A" ;
float DEPTH(TIME) ;
DEPTH:coordinates = "TIME LATITUDE LONGITUDE NOMINAL_DEPTH" ;
DEPTH:standard_name = "depth" ;
DEPTH:long_name = "actual depth" ;
DEPTH:units = "metres" ;
DEPTH:reference_datum = "sea surface" ;
DEPTH:valid_min = -5.f ;
DEPTH:valid_max = 12000.f ;
DEPTH:_FillValue = 999999.f ;
DEPTH:comment = "depthPP: Depth computed using the Gibbs-SeaWater toolbox (TEOS-10) v3.02 from latitude and absolute pressure measurements to which a nominal value for atmospheric pressure (10.1325 dbar) has been substracted." ;
DEPTH:ancillary_variables = "DEPTH_quality_control" ;

byte DEPTH_quality_control(TIME) ;
DEPTH_quality_control:long_name = "quality flag for depth" ;
DEPTH_quality_control:standard_name = "depth status_flag" ;
DEPTH_quality_control:_FillValue = 99b ;
DEPTH_quality_control:quality_control_conventions = "IMOS standard flags" ;
DEPTH_quality_control:flag_values = 0b, 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b ;
DEPTH_quality_control:flag_meanings = "No_QC_performed Good_data Probably_good_data Bad_data_that_are_potentially_correctable Bad_data Value_changed Not_used Not_used Not_used Missing_value" ;
DEPTH_quality_control:quality_control_global_conventions = "Argo reference table 2a (see http://www.cmar.csiro.au/argo/dmqc/user_doc/QC_flags.html), applied on data in position only (between global attributes time_deployment_start and time_deployment_end)" ;
DEPTH_quality_control:quality_control_global = "A" ;

// global attributes:
:toolbox_input_file = "/home/ggalibert/Documents/IMOS_toolbox/data_files_examples/NSW/DATA/MOORINGS/RAW/PH100/019_PH100_20Jun2011/AQUAtec/csv/PH100_520PT_20Jun2011_564.csv" ;
:toolbox_version = "2.4 - GLNXA64" ;
:file_version = "Level 1 - Quality Controlled Data" ;
:file_version_quality_control = "Quality controlled data have passed quality assurance procedures such as automated routines and sensor calibration or visual inspection and removal of obvious errors. The data are in physical units using standard SI metric units with calibration and other pre-processing routines applied, all time and location values are in absolute coordinates to comply with standards and datum. Metadata exists for the data or for the higher level dataset that the data belongs to. This is the standard IMOS data level and is what should be made available to eMII and to the IMOS community." ;
:project = "Integrated Marine Observing System (IMOS)" ;
:Conventions = "CF-1.6,IMOS-1.3" ;
:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table 27" ;
:institution = "ANMN-NSW" ;
:date_created = "2015-02-25T01:10:55Z" ;
:abstract = "NSW-IMOS Port Hacking 100m Mooring" ;
:comment = "Geospatial vertical min/max information has been computed using the Gibbs-SeaWater toolbox (TEOS-10) v3.02 from latitude and absolute pressure measurements to which a nominal value for atmospheric pressure (10.1325 dbar) has been substracted." ;
:source = "Thermistor String" ;
:instrument = "Aquatec Aqualogger 520PT" ;
:keywords = "Aqualogger 520PT, TIME, LATITUDE, LONGITUDE, NOMINAL_DEPTH, TEMP, PRES, DEPTH" ;
:keywords_vocabulary = “IMOS parameter names. See https://github.com/aodn/imos-toolbox/blob/master/IMOS/imosParameters.txt”
:references = "http://www.imos.org.au" ;
:site_code = "PH100" ;
:platform_code = "PH100" ;
:deployment_code = "PH100-1106" ;
:featureType = "timeSeries" ;
:naming_authority = "IMOS" ;
:instrument_serial_number = "023-564" ;
:instrument_sample_interval = 300. ;
:history = "2015-02-25T01:11:21Z - depthPP: Depth computed using the Gibbs-SeaWater toolbox (TEOS-10) v3.02 from latitude and absolute pressure measurements to which a nominal value for atmospheric pressure (10.1325 dbar) has been substracted." ;

:quality_control_log = "imosImpossibleDateQC(dateMin=01/01/2007, dateMax=10/02/2015) did not fail on any TIME sample.\nimosImpossibleLocationSetQC(distanceKmPlusMinusThreshold=2.5) did not fail on any LATITUDE sample.\nimosImpossibleLocationSetQC(distanceKmPlusMinusThreshold=2.5) did not fail on any LONGITUDE sample.\nimosInOutWaterQC(in=20/06/11 12:55:00, out=31/08/11 13:30:00) flagged 1601 TEMP samples with flag Bad_data.\nimosInOutWaterQC(in=20/06/11 12:55:00, out=31/08/11 13:30:00) flagged 1601 PRES samples with flag Bad_data.\nimosInOutWaterQC(in=20/06/11 12:55:00, out=31/08/11 13:30:00) flagged 1601 DEPTH samples with flag Bad_data.\nimosGlobalRangeQC(min=-2.5, max=40) did not fail on any TEMP sample.\nimosGlobalRangeQC(min=-5, max=12000) did not fail on any PRES sample.\nimosGlobalRangeQC(min=-5, max=12000) did not fail on any DEPTH sample.\nimosImpossibleDepthQC(zNominalMargin=15, maxAngle=70 => min=99.7923, max=143.1251) did not fail on any PRES sample.\nimosImpossibleDepthQC(zNominalMargin=15, maxAngle=70 => min=89, max=132) did not fail on any DEPTH sample." ;

:geospatial_lat_min = -34.1203333333 ;

:geospatial_lat_max = -34.1203333333 ;

:geospatial_lon_min = 151.22415 ;

:geospatial_lon_max = 151.22415 ;

:instrument_nominal_height = 6. ;

:instrument_nominal_depth = 104. ;

:site_nominal_depth = 110. ;

:geospatial_vertical_min = 105.41f ;

:geospatial_vertical_max = 105.41f ;

:geospatial_vertical_positive = "down" ;

:time_deployment_start = "2011-06-20T12:55:00Z" ;

:time_deployment_start_origin = "TimeFirstInPos" ;

:time_deployment_end = "2011-08-31T13:30:00Z" ;

:time_deployment_end_origin = "TimeLastInPos" ;

:time_coverage_start = "2011-06-16T23:00:00Z" ;

:time_coverage_end = "2011-09-02T13:00:00Z" ;

:data_centre = "eMarine Information Infrastructure (eMII)" ;

:data_centre_email = "info@emii.org.au" ;

:author_email = "t.austin@unsw.edu.au" ;

:author = "Austin, Tim" ;

:principal_investigator = "Roughan, Moninya" ;

:principal_investigator_email = "mroughan@unsw.edu.au" ;

:institution_references = "http://www.imos.org.au/emii.html" ;

:citation = "The citation in a list of references is: \"IMOS [year-of-data-download], [Title], [data-access-url], accessed [date-of-access]\"" ;

:acknowledgement = "Any users of IMOS data (including re-packagers) are required to clearly acknowledge the source of the material in this format: \"Data was sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative\"." ;

:use_limitation = "Data, products and services from IMOS are provided \"as is\" without any warranty as to fitness for a particular purpose." ;

:license = “http://creativecommons.org/licenses/by/4.0/”

}

APPENDIX 2: IMOS TOOLBOX OPTIONAL GLOBAL ATTRIBUTES

The IMOS-Toolbox has been developed by the Australian National Mooring Network, supported by IMOS and the eMarine Information Infrastructure. It is written in MATLAB and Java with a graphical user interface and aims at converting oceanographic data files into pre-processed and quality controlled netCDF files. This IMOS toolbox is freely available in a standalone executable with its source code. More documentation and downloads can be found on the imos-toolbox GitHub page. When correctly configured, this toolbox automatically documents these optional global attributes:

Name	Type	Example	Definition
What			
toolbox_input_file	S	toolbox_input_file = "E:\Documents and Settings\ggalibert\My Documents\IMOS_toolbox\data_files_examples\NSW\DATA\MOORINGS\SYD100\RAW\021_SYD100_15Dec2010\WQM\ASCII\WQM0141_031.DAT"	Full local path and filename of the original data file processed by the toolbox.
toolbox_version	S	toolbox_version = "2.1b"	Version of the toolbox used to process data.

Non-CF attribute

deployment_code	S	deployment_code = “NRSMAI-0807”	Deployment unique code within IMOS project, usually composed of a site_code and a date information in format YYMM or YYMMDD. Its content can be adapted to what suits best any particular needs of a facility. A deployment refers to a specific time period over which a specific platform (e.g. mooring) is continuously collecting measurements at a specific location.
instrument_sample_interval	N	instrument_sample_interval = 1	Sampling interval in seconds performed by the instrument on this data set.
instrument_beam_angle	N	instrument_beam_angle = 25	Angle between a transducer beam’s main axis and the vertical axis of the ADCP.
instrument_burst_interval	N	instrument_burst_interval = 900	Interval in seconds between two bursts of data collection performed by the instrument on this data set. Note that not all instruments are sampling data in bursts.
instrument_burst_duration	N	instrument_burst_duration = 120	Duration in seconds of a burst. Note that not all instruments are sampling data in bursts.
cruise	S	cruise = “125456”	Reference to the cruise during which the dataset was collected.
station	S	station = “1”	Reference to the station where the dataset (cast) was collected.

Non-CF attribute

Where

instrument_nominal_depth	N	instrument_nominal_depth = 90	Instrument nominal depth below sea surface in metres.
instrument_nominal_height	N	instrument nominal_height = 0	Instrument nominal depth above sea floor in metres.
site_nominal_depth	N	site_nominal_depth = 90	Site nominal depth below sea surface in metres.
site_depth_at_deployment	N	site_depth_at_deployment = 84	Measured depth on site at deployment in metres.
When			
time_deployment_start	S	time_deployment_start = “2008-11-23T10:16:00Z”	Start date in UTC when the instrument is deployed in its nominal position. See section 3.2.4 - on time format.
time_deployment_start_origin	S	time_deployment_start_origin = "TimeFirstInPos"	Origin of time_deployment_start. Can be : TimeFirstGoodData TimeFirstInPos TimeFirstWet TimeSwitchOn
time_deployment_end	S	time_deployment_end = “2009-01-06T09:43:00Z”	Final date in UTC when the instrument is retrieved from its nominal position. See section 3.2.4 - on time format.

Non-CF attribute

time_deployment_end_origin	S	time_deployment_end_origin = "TimeLastInPos"	Origin of time_deployment_end. Can be : TimeLastGoodData TimeLastInPos TimeOnDeck TimeSwitchOff

APPENDIX 3: IMOS FILE NAMING CONVENTION

IMOS Integrated Marine Observing System

FACILITY 10: eMarine Information Infrastructure (eMII)

IMOS NETCDF FILE NAMING CONVENTION

Version 1.5
August, 2015

info@emii.org.au

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is led by University of Tasmania in partnership with the Australian marine & climate science community

UNIVERSITY of TASMANIA
AUSTRALIA

Table of contents

PREFACE to version 1.5

An extra **data code**: ‘Z’ for any vertical reference parameter has been incorporated in 1.1.2 - Reference Table 2. This data code also replaces the data code ‘P’.

The list of **platforms** and **platform codes** included in 1.1.3 Reference Table 3 has been updated.

File Version definitions in 1.1.4 have been updated.

Prefaces to previous versions of this document have been removed.

1 - FILE NAMING CONVENTION

For many data types, **IMOS** uses the netCDF (network Common Data Form) system, a set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.

The main purpose of this document is to specify the format of filenames that will be used to distribute **IMOS** data in netCDF format.

IMOS netCDF file naming conventions are based on those prescribed by the **OceanSITES** User's Manual, version 1.1. The **OceanSITES** program is a global network of open-ocean sustained time series reference stations that have been implemented by an international partnership of researchers. More information about this project is available at http://www.oceansites.org.

1.1 - Data file naming convention

The file name extension of each **netCDF file** must be **".nc".**

Filenames can be up to 255 characters in length and are composed of up to 10 fields separated by **'_'** (underscore) characters.

Characters which can be used within fields are letters (A to Z) and whole numbers (0 to 9). The hyphen character (-) may also be used within fields.

The NetCDF file name format is:

IMOS_<Facility-Code>_<Data-Code>_<Start-date>_<Platform-Code>_FV<File-Version>_

<Product-Type>_<End-date>_<Creation_date>_<PARTX>.nc

The first 6 fields are mandatory and must conform to the following content guidelines:

1. IMOS: Name of the project[1]

[1] Any data produced by the IMOS project should be instantly identifiable as 'IMOS' data

2. <Facility-Code>: code representing a facility (and a sub-facility if applicable) (see 1.1.1 - Reference Table 1: Facility Codes).

3. <Data-Code>: list of data codes in alphabetical order from reference table 2. The data codes are descriptors of the primary parameters measured. Data codes do not list secondary parameters (see 1.1.2 - Reference Table 2: Data Codes).

4. <Start-date>: start date and time of the measurement, not of file creation. The date and time are formatted to international standard ISO8601. eMII requests that the time be in UTC.

   Date format is: YYYYMMDDTHHMMSSZ where T is the delimiter between date and time and Z indicates that time is in UTC. If time is not in UTC, local time must be shown as hours plus or minus from the longitudinal meridian. Z is not appended when local time is used. Examples of the time format are below.

   - 20081024T080000Z (UTC)
   - 20081024T180000+10 (Local)
   - 20081024T020000-06 (Local)

5. <Platform-Code>: code representing the platform[2] (see 0 Reference Table 3: Platform Codes).

6. <File-Version>: value representing the version of the file (see 1.1.4 Reference Table 4: File Version Codes).

The following 4 fields are optional:

7. <Product-Type>: This code will give information about the product included in the dataset.

[2] **Notes on platform codes:** The platform codes for data file naming conventions (reference table 2) are unique and if any is missing please contact info@emii.org.au.

Platform codes must be unique within an **IMOS** facility and must apply to either one particular unit of equipment or to one particular location.

To finalise platform codes, eMII needs more information about the formats of different 'platform' codes that are currently used by each facility. eMII anticipate that the codes already in use within many facilities will be suitable.

Characters which can be used are capital letters (A to Z) and whole numbers (0 to 9). The hyphen character (-) may also be used.

8. <End-date>: end date and time of the measurement. The data format is the same as the start date and preceded by the following characters “END-“. An example of the format of the end date should be: “END-20081112T231255Z”

9. <Creation-date>: creation date and time of the file. The data format is the same as the start and end date and should be preceded by the characters “C-“. An example of the format of the creation date should be “C-20081112T231255Z”.

10. <PARTX>: when an IMOS data file size becomes excessive (e.g.: >100Mb), it can be split in smaller parts: PART1, PART2, … PARTN.

1.1.1 - Reference Table 1: Facility Codes

Facility	Sub-Facility (if applicable)	Code
Argo		ARGO
SOOP	Multi-disciplinary Underway Network XBT	SOOP-XBT
	Multi-disciplinary Underway Network CO2	SOOP-CO2
	Multi-disciplinary Underway Network CPR	SOOP-CPR
	Sensors on Tropical Research Vessels	SOOP-TRV
	Sea Surface Temperature Sensors	SOOP-SST
	Research Vessel Real Time Air-Sea Fluxes	SOOP-ASF
	Bio-Acoustic	SOOP-BA
	Sensors on Temperate Merchant Vessels	SOOP-TMV
ABOS	Southern Ocean Time Series	ABOS-SOTS
	Air-Sea Flux Stations	ABOS-ASFS
	Deepwater Arrays	ABOS-DA
ANFOG		ANFOG
AUV		AUV
ANMN	Queensland and Northern Australia	ANMN-QLD
	New South Wales	ANMN-NSW
	Southern Australia	ANMN-SA
	Western Australia	ANMN-WA
	Passive Acoustic Observatories	ANMN-PA
	National Reference Stations Analysis and Coordination	ANMN-NRS
	Acidification Moorings	ANMN-AM
ACORN		ACORN
AATAMS		AATAMS
FAIMMS		FAIMMS
SRS	Australian Satellite SST L2P Products	SRS-A

	Australian Ocean Distributed Archive and Access Centre	SRS-B
	Satellite Altimetry Calibration and Validation	SRS-Altimetry
	Bio-Optical database of Australian waters	SRS-OC-BODBAW
	Lucinda Jetty Coastal Observatory	SRS-OC-LJCO

1.1.2 - Reference Table 2: Data Codes

Data Code	Meaning
A	Acoustic measurements
B	Biology (plankton, fluorescence)
C	Conductivity (electrical conductivity of sea water)
E	Engineering or technical parameters
F	Fluxes (e.g. radiation, latent heat, sensible heat)
G	Gas (measurement and fluxes)
I	Images
K	Chemistry (nutrients, trace metals)
M	Meteorological parameters (e.g. wind, air pressure, air temperature)
O	Oxygen concentration (in sea water)
R	Raw data
S	Salinity (of sea water)
T	Temperature (of sea water)
U	Turbidity (of sea water)
V	Velocity (of sea water)
W	Wave parameters (significant wave height, peak period, peak direction …)
Z	Vertical reference parameters (pressure, depth, height_above_sensor, ...)

1.1.3 Reference Table 3: Platform Codes

	Facility	Sub-facility	Platform Codes	Platform Description	Code Description
1	Argo		Argo convention		No change to Argo data/file name formats
2	SOOP	XBT	PX34	Sydney - Wellington	XBT line identifier
			IX28	Hobart - Dumont D'Urville	
			PX30-31	Brisbane – Noumea - Suva/ Lautoka	
			IX1	Fremantle - Sunda Strait	
			IX12	Fremantle - Red Sea	
			PX2	Flores Sea - Torres Strait	
			IX22-PX11	Port Hedland - Japan	
			IX15-IX31	Mauritius – Fremantle-Melbourne	
			IX15	Mauritius- Fremantle	
			IX21-IX06	Cape of Good Hope – Mauritius – Malacca Strait	
			IX21	Cape of Good Hope - Mauritius	
			IX8	Mauritius - Bombay	
			IX9	Fremantle – Persian Gulf	
			PX06	Suva - Auckland	
			PX13	New Zealand - California	
			PX17	Tahiti - Panama	
			PX28	Tahiti – Auckland	
			PX31	Noumea - Suva	
			PX33	Hobart – Macquarie Island	
			PX35	Melbourne - Dunedin	
			PX3	Coral Sea	
			PX55	Melbourne – Wellington	
			PX57	Brisbane – Wellington	
			PX5	Brisbane – Japan	
			SO	Southern Ocean	
			Tasman-Sea	Tasman Sea	
		CO2	VLHJ	RV Southern Surveyor	Ship callsign
			FHZI	RV L'Astrolabe	
			VNAA	RSV Aurora Australis	
			ZMFR	RV Tangaroa	
		CPR	Unknown		ID for CPR deployed, 2-6 letter/number codes eg. Unit 1 = U001 *or*

					CPR line if more appropriate
		BA	ZMTW	Janas	Ship callsign
			ZM 7552	Kaharoa	
			E5WW	Will Watch	
			VLHJ	Southern Surveyor	
			VNAA	Aurora Australis	
			VHGI	Southern Champion	
			ZMRE	Rehua	
			LFB13191P	Santo Rocco	
			VHLU	Austral Leader II	
			WTEE	Oscar Elton Sette	
		TMV	VLST	MV Spirit of Tasmnia I	Ship callsign
		Trop Res	VNCF	Cape Ferguson	Ship callsign
			VMQ9273	Solander	
		SST	VLHJ	RV Southern Surveyor	Ship callsign
			VHW5167	MV Seaflyte (Rottnest Island Ferry)	
			FHZI	RV L'Astrolabe	
			HSB3402	MV Xutra Bhum	
			HSB3403	MV Wana Bhum	
			VHW6005	RV Linnaeus	
			VNAA	RSV Aurora Australis	
			VLST	MV Spirit of Tasmania I	
			VNSZ	MV Spirit of Tasmania II	
			VJQ7467	MV Fantasea (Whitsundays Ferry)	
			VRDU8	OOCL Panama	
			C6FS9	MV Stadacona	
			VNAH	MV Portland	
			MNPJ3	MV Pacific Sun	
			VROB	MV Highland Chief	
			VNVR	MV Iron Yandi	
			V2BJ5	MV ANL Yarunga	
			VRZN9	Pacific Celebes	
			9HA2479	Pacific Sun	
			ZMFR	RV Tangaroa	
		A-S Flux		As for SST Platform Codes	Ship callsign
3	ABOS	ABOS-SOTS	SAZOTS	Sub-Antarctic Sediment trap mooring	
			PULSE5H	Pulse 5 'heavy' mooring	
			PULSE5L	Pulse 5 'light' mooring	
			PULSE6	Pulse 6 mooring	
		ABOS-SOFS	SOFS	Southern Ocean Flux	

				Station mooring	
		ABOS-DA	EAC1	East Australian Current 1 mooring	
			EAC2	East Australian Current 2 mooring	
			EAC3	East Australian Current 3 mooring	
			EAC4	East Australian Current 4 mooring	
			EAC5	East Australian Current 5 mooring	
			ITFOMB	Ombai mooring	
			ITFTIN	Timor North mooring	
			ITFTSL	Timor Sill mooring	
			POLYNYA1	Polynya 1 mooring	
			POLYNYA2	Polynya 2 mooring	
			POLYNYA3	Polynya 3 mooring	
4	ANFOG		SG151	Seaglider	Manufacturer unit number
			SG152	Seaglider	
			SG153	Seaglider	
			SG154	Seaglider	
			SG155	Seaglider	
			SG514	Seaglider	
			SG516	Seaglider	
			SG517	Seaglider	
			SG519	Seaglider	
			SG520	Seaglider	
			SG521	Seaglider	
			SG540	Seaglider	
			SL084	Slocum	
			SL190	Slocum	
			SL209	Slocum	
			SL210	Slocum	
			SL239	Slocum	
			SL248	Slocum	
			SL281	Slocum	
			SL286	Slocum	
			SL287	Slocum	
			SL130	Slocum	
			SL104	Slocum	
			SL106	Slocum	
			SL109	Slocum	
5	AUV		SIRIUS		If other AUVs are recruited to the facility, they will need codes
6	ANMN	QLD	GBROTE	One Tree East	AIMS mooring codes

			GBRHIS	Heron Island South	
			GBRHIN	Heron Island North	
			GBRELR	Elusive Reef	
			GBRCCH	Capricorn Channel	
			GBRMYR	Myrmidon	
			GBRPPS	Palm Passage	
			GBRLSH	Lizard Shelf	
			GBRLSL	Lizard Slope	
			ITFJBG	Joseph Bonaparte Gulf	
			ITFFTB	Flat Top Banks	
			ITFMHB	Margaret Harries Banks	
			ITFTIS	Timor South	
			KIM050	Kimberley 50m	
			KIM100	Kimberley 100m	
			KIM200	Kimberley 200m	
			KIM400	Kimberley 400m	
			PIL050	Pilbara 50m	
			PIL100	Pilbara 100m	
			PIL200	Pilbara 200m	
		NSW	BMP090	Batemans Marine Park 90m	NSW-IMOS mooring codes
			BMP120	Batemans Marine Park 120m	
			CH100	Coffs Harbour 100m	
			CH070	Coffs Harbour 70m	
			SYD100	Sydney 100m	
			SYD140	Sydney 140m	
			PH100	Port Hacking 100m	
			JB070	Jervis Bay	
			ORS065	Ocean Reference Station Sydney	
		SA	SAM1DS	M1 Deep Slope	SAIMOS mooring codes
			SAM2CP	M2 Cabbage Patch	
			SAM3MS	M3 Mid-Slope	
			SAM4CY	M4 Canyons	
			SAM5CB	M5 Coffin Bay	
			SAM6IS	M6 Investigator Strait	
			SAM7DS	M7 Deep-Slope	
			SAM8SG	M8 Spencer Gulf Mouth	
		WA	WATR05	Two Rocks 50m	WAIMOS mooring codes
			WATR10	Two Rocks 100m	
			WATR15	Two Rocks 150m	
			WATR20	Two Rocks 200m (BGC)	
			WATR50	Two Rocks 500m	
			WACA20	Canyon 200m Head	

				(BGC)	
			WACANO	Canyon 500m North	
			WACASO	Canyon 500m South	
		Acoustic	PAPCA1	Perth Canyon, WA 1	Acoustic mooring site codes
			PAPCA2	Perth Canyon, WA 2	
			PAPCA3	Perth Canyon, WA 3	
			PAPCA4	Perth Canyon, WA 4	
			PAPOR1	Portland, VIC 1	
			PAPOR2	Portland, VIC 2	
			PAPOR3	Portland, VIC 3	
			PAPOR4	Portland, VIC 4	
			PASYD1	Sydney, NSW 1	
			PASYD2	Sydney, NSW 2	
			PASYD3	Sydney, NSW 3	
			PASYD4	Sydney, NSW 4	
		NRS	NRSYON	Yongala, QLD	NRS site codes (multiple platforms at some sites)
			NRSDAR	Darwin, NT	
			NRSROT	Rottnest, WA	
			NRSMAI	Maria Island, TAS	
			NRSKAI	Kangaroo Island, SA	
			NRSESP	Esperance, WA	
			NRSNIN	Ningaloo, WA	
			NRSNSI	North Stradbroke Island, QLD	
			NRSPHB	Port Hacking, NSW	
		AM	NRSMAI	Maria Island, TAS	NRS site code where acidification mooring is located
			NRSESP	Esperance, WA	
			NRSYON	Yongala, QLD	
7	ACORN		CBG	Capricorn Bunker Group	ACORN codes
			TAN	CBG Tannum Sands	
			LEI	CBG Lady Elliot Island	
			SAG	South Australia Gulf	
			CSP	SAG Cape Spencer	
			CWI	SAG Cape Wiles	
			BONC	Bonnie Coast	
			NOCR	BONC Noora Creena	
			BFCV	BONC Blackfellows cave	
			COF	Coffs Harbour	
			RRK	COF Red Rock	
			NNB	COF North Nambucca	
			ROT	Rottnest Shelf	
			FRE	ROT Fremantle	
			GUI	ROT Guilderton	
			TURQ	Turquoise Coast	
			GHED	TURQ Green Head	

			LANC	TURQ Lancelin	
			SBRD	TURQ Seabird	
			CRVT	TURQ Cervantes	
8	AATAMS		SYD1	Sydney line (1-30)	Location and receiver position e.g. SYD1 = Sydney line position 1, SYD30 = Sydney line position 30.
			PER1	Perth line (1-30)	
			NRETAN1	Ningaloo Reef Ecological Tracking Array North line (1-7)	
			NRETAC1	NRETA Central line (1-7)	
			NRETAS1	NRETA South line (1-18)	
			MAL1	Mallacoota line (1-30)	
			PORT1	Portland line (1-30)	
			COF1	Coffs Harbour line (1-30)	
9	FAIMMS		HIRP1	Heron Island Relay Pole 1	AIMS sensor network codes eg. Heron Island Relay Pole 1 = HIRP1.
			HIRP2	Heron Island Relay Pole 2	
			HIRP3	Heron Island Relay Pole 3	
			HIRP4	Heron Island Relay Pole 4	
			HIRP5	Heron Island Relay Pole 5	
			HIRP6	Heron Island Relay Pole 6	
			HISF1	Heron Island Sensor Float 1	
			HISF2	Heron Island Sensor Float 2	
			HISF3	Heron Island Sensor Float 3	
			HISF4	Heron Island Sensor Float 4	
			HISF5	Heron Island Sensor Float 5	
			HIWS	Heron Island Weather Station	
			HIBSE	Heron Island Base Station	
			DAVSF1	Davis Reef Sensor Float 1	
			DAVSF2	Davis Reef Sensor Float 2	
			DAVSF3	Davis Reef Sensor Float 3	
			DAVSF4	Davis Reef Sensor Float 4	
			DAVSF5	Davis Reef Sensor Float 5	
			LIZRP2	Lizard Island Relay Pole 2	
			LIZSF1	Lizard Island Sensor Float1	
			LIZSF2	Lizard Island Sensor Float2	
			LIZSF3	Lizard Island Sensor Float3	
			LIZSF4	Lizard Island Sensor Float4	

			LIZWS	Lizard Island weather station	
			OTIRP1	One Tree Island Relay Pole 1	
			OTIRP2	One Tree Island Relay Pole 2	
			OTIRP3	One Tree Island Relay Pole 3	
			OTIWS	One Tree Island Weather Station	
			OTIBSE	One Tree Island Base Station	
			OIRP1	Orpheus Island Relay Pole1	
			OIRP2	Orpheus Island Relay Pole2	
			OIRP3	Orpheus Island Relay Pole3	
			OISF1	Orpheus Island Sensor Float 1	
			OISF2	Orpheus Island Sensor Float 2	
10	SRS	ALT	STO	Storm bay	Data products in netCDF format may need defining 'codes', eg. SSTL2P. These codes may necessarily be quite complex.
			BAS	Bass strait	
		OC-BODBAW			Ship callsign
		OC-SOOP_Rad	VMQ9273	Solander	Ship callsign
			VLHJ	RV Southern Surveyor	

1.1.4 Reference Table 4: File Version Codes

The File Version code will enable a file creator to specify the processing version of the file. The different data levels listed below were derived from a discussion paper "Data Standards Framework for the IMOS Instrument Data" prepared by Scott Bainbridge (AIMS) for the AODCJF.

File Version	Definition	Description
FV00	Level 0 – Raw data	Raw data is defined as unprocessed data and data products that have not undergone quality control. The data may be in engineering or physical units, time and location details can be in relative units and values can be pre-calibration measurements. Level 0 data is not suitable for public access within IMOS.
FV01	Level 1 – Quality Controlled data	Quality controlled data have passed quality assurance procedures such as automated routines and sensor calibration or visual inspection and removal of obvious errors. The data are in physical units using standard SI metric units with calibration and other pre-processing routines applied, all time and location values are in absolute coordinates to comply with standards and datum. Data includes flags for each measurement to indicate the estimated quality of the measurement. Metadata exists for the data or for the higher level dataset that the data belongs to. This is the standard IMOS data level and is what should be made available to eMII and to the IMOS community.
FV02	Level 2 – Derived Products	Derived products require scientific and technical interpretation. Normally these will be defined by the community that collects or utilises the data.
FV03	Level 3 – Interpreted Products	These products require researcher driven analysis and interpretation, model based interpretation using other data and / or strong prior assumptions.
FV04	Level 4 – Knowledge Products	These products require researcher driven scientific interpretation and multidisciplinary data integration and include model-base interpretation using other data and/or strong prior assumptions.

1.2 - Examples

Example data file names for each **IMOS** facility can be found in this section. These examples are suggestions only.

Please provide eMII with feedback on this discussion document if you believe that these suggestions will not work for your facility.

1.2.1 -Facility 1: ARGO

eMII intend to use the internationally accepted Argo netCDF conventions for GDAC data file naming, ie:

<FloatID>_prof.nc, <FloatID>_traj.nc, <FloatID>_meta.nc, <FloatID>_tech.nc

1.2.2 -Facility 2: SOOP

Multidisciplinary Underway Network

XBT

IMOS_SOOP-XBT_T_20091223T140300Z_PX2_FV01_ID-134215.nc

This file would contain quality controlled Temperature data starting from the 23rd of December 2009 at 14:03 UTC and collected along XBT line PX2 by the XBT group in the **IMOS** SOOP Multidisciplinary Underway Network sub-facility.

CO2

IMOS_SOOP-CO2_GST_20080901T120000Z_VLHJ_FV01.nc

This file would contain quality controlled Gas, Salinity and Temperature data starting from the 1st September 2008 at 12:00 UTC and collected with the CO2 system (and associated underway systems) on the Southern Surveyor by the CO2 group in the **IMOS** SOOP Multidisciplinary Underway Network sub-facility.

Bio-acoustic

IMOS_SOOP-BA_AE_20130623T065936Z_VLHJ_FV02_Southern-Surveyor-EK60-38-120_END-20130625T002210Z_C-20140815T061308Z.nc

This file would contain a product of quality controlled acoustic and engineering parameters collected on RV Southern Surveyor (callsign VLHJ) from an EK60 acoustic transducer operating at 38kHz and sampling 120 vertical cells during a cruise between the 23rd of July 2013 to the 25th of July 2013 created by the **IMOS** SOOP Bio-acoustic sub-facility on the 15th of August 2014.

Temperate Merchant Vessel

IMOS_SOOP-TMV_TSB_20120131T084302Z_VLST_FV02_transect-D2M_END-20120131T184852Z.nc

This file would contain a product of quality controlled temperature, salinity and biology parameters collected on MV Spirit of Tasmania I (callsign VLST) during transect Devonport to Melbourne between the 31st of January 2012 to the 31st of January 2012 by the **IMOS** SOOP TMV sub-facility.

Sensors on Tropical Research Vessels

IMOS_SOOP-TRV_T_20080930T002727Z_VNCF_FV01_END-20081013T093401Z.nc

This file would contain quality controlled temperature data collected on RV Cape Ferguson during a cruise between the 30th of September 2008 to the 13th of October 2008 by the **IMOS** SOOP Sensors on Tropical Research Vessels sub-facility.

SST

IMOS_SOOP-SST_T_20081030T122500Z_VHW5167_FV01_C-20140815T061308Z.nc

This file would contain quality controlled Temperature data starting from the 30th of October 2008 at 12:25 UTC, collected from the Rottnest Island Ferry (callsign VHW5167) created by the **IMOS** SOOP SST sub-facility on the 15th of August 2014.

Air-Sea Flux

IMOS_SOOP-ASF_MT_20080204T100000Z_VLHJ_FV01_C-20140815T061308Z.nc

This file would contain quality controlled Meteorological and Temperature data starting from the 4th of February 2008 at 10:00 UTC, collected from the Southern Surveyor (callsign VLHJ) created by the **IMOS** SOOP Air-Sea Flux sub-facility on the 15th of August 2014.

1.2.3 -Facility 3: SOTS

IMOS_ABOS-SOTS_20090928T000000Z_PULSE_FV01_PULSE-6-2009_END-20100318T030000Z_C-20140603T061638Z.nc

This file would contain quality controlled data starting from the 28th September 2009 at 00:00 UTC to the 18th March 2010 at 03:00 UTC collected by the 6th deployment of the Pulse mooring and created by the **IMOS** ABOS-SOTS facility on the 3rd June 2014.

1.2.4 -Facility 4: ANFOG

IMOS_ANFOG_BCEOPSTUV_20130530T233430Z_SG516_FV01_timeseries_END-20130721T161753Z.nc

This file would contain quality controlled Biology, Conductivity, Engineering, Oxygen, Pressure, Salinity, Temperature, Turbidity and Current Velocity data starting from the 30th May 2013 at 23:34:30 UTC to the 21st July 2013 at 16:18 UTC, collected by Seaglider Unit 516 of the **IMOS** ANFOG facility.

1.2.5 -Facility 5: AUV

IMOS_AUV_ST_20080812T122500Z_SIRIUS_FV00.nc

This file would contain raw Temperature and Salinity data starting from the 12th August 2008 at 12:25 UTC collected by AUV Sirius of the **IMOS** AUV facility.

1.2.6 -Facility 6: ANMN

6a Qld and Northern Aust

IMOS_ANMN-QLD_VATPE_20111017T062000Z_GBRMYR_FV01_GBRMYR-1110-Continental-194_END-20120412T221800Z_C-20121112T033900Z.ncThis file would contain quality controlled

Current Velocity, Acoustic, Temperature, Pressure and Engineering data starting from the 17th October 2011 at 06:20 UTC to the 12th April 2012 at 22:18 UTC, collected at the Myrmidon mooring site during deployment 1110 by a Nortek Continental ADCP set at the nominal depth of 194 metres and created by the **IMOS** ANMN Queensland and Northern Australia sub-facility the 12th November 2012.

6b NSW

IMOS_ANMN-NSW_TZ_20140603T033500Z_PH100_FV01_PH100-1406-Aqualogger-520T-96_END-20140910T234500Z_C-20141028T023153Z.ncThis file would contain quality controlled Temperature and Depth data starting from the 3rd June 2014 at 03:35 UTC to the 10th September 2014 at 23:45 UTC, collected at the Port Hacking 100m mooring site during the deployment 1406 by an Aqualogger 520T set at the nominal depth of 96 metres and created by the **IMOS** ANMN NSW sub-facility the 28th October 2014.

1.2.7 -Facility 7: ACORN

IMOS_ACORN_RV_20150323T020000Z_NOCR_FV00_radial.nc

This file would contain raw Current Velocity radial data on 23rd of March 2015 at 02:00 UTC from the South Australia radar station Nora Creina, from the **IMOS** ACORN facility.

IMOS_ACORN_V_20140606T133000Z_ROT_FV01_1-hour-avg.nc

This file would contain quality controlled hourly averaged Current Velocity data on 6th of July 2014 at 13:30 UTC from the Western Australia radar site Rottnest Shelf, from the **IMOS** ACORN facility.

1.2.8 -Facility 8: AATAMS

IMOS_AATAMS-SATTAG_TSP_20110420T023000Z_Q9900434_END-20110422T230000Z_FV00.ncThis file would contain raw Temperature, Salinity and Pressure data starting from the 20th April 2011 at 02:30 UTC to 22nd April 2011 at 23:00 UTC transmitted by satellite tag transmitter WMO code Q9900434 the **IMOS** AATAMS-SATTAG facility.

1.2.9 -Facility 9: FAIMMS

IMOS_FAIMMS_T_20081201T015928Z_HIRP1_FV01_END-20090101T000000Z_C-20141107T163648Z.ncThis file would contain quality controlled Temperature data from the 1st December 2008 at 01:59 UTC to the 1st of January 2009 at 00:00 UTC collected on Heron Island Relay Pole 1 and created by the **IMOS** FAIMMS facility on the 7th of November 2014.